Computing in the RAIN: Reliable Array of Independent Nodes

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Parallel and Distributed Environments

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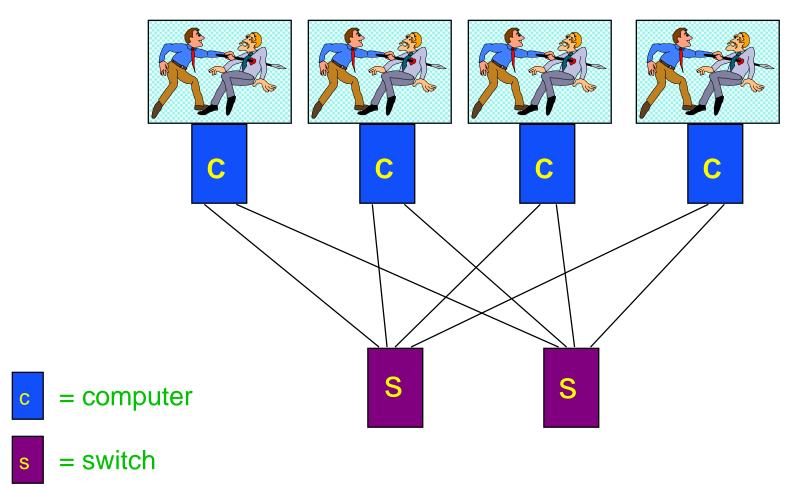
Kevin Foltz

Marc Riedel

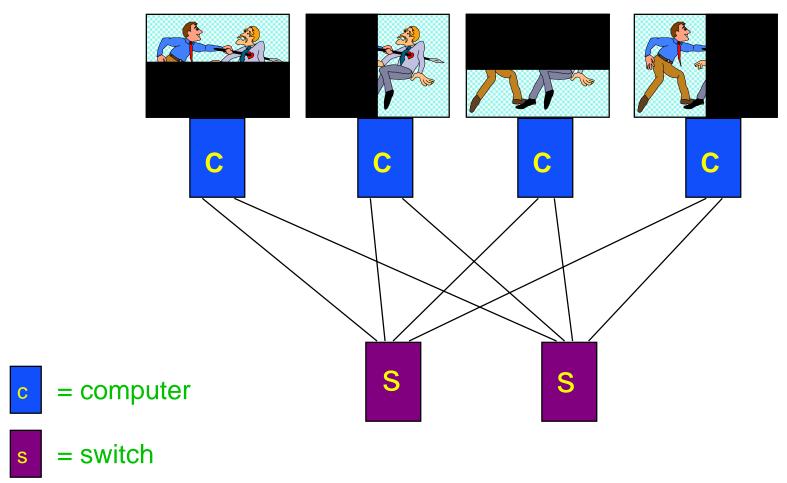
Massimo Franceschetti

Lihao Xu

Initial Prototype



Limited Storage



2 out of 4 Code

a

c+d

b

a+d

C

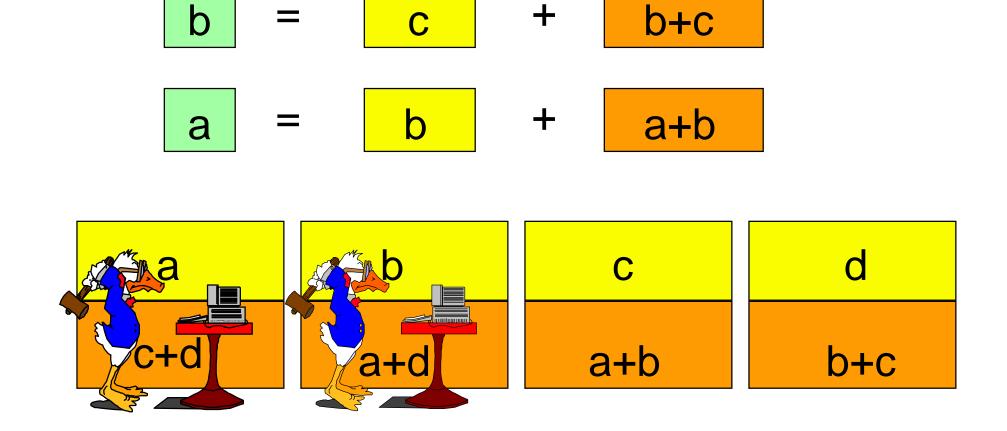
a+b

C

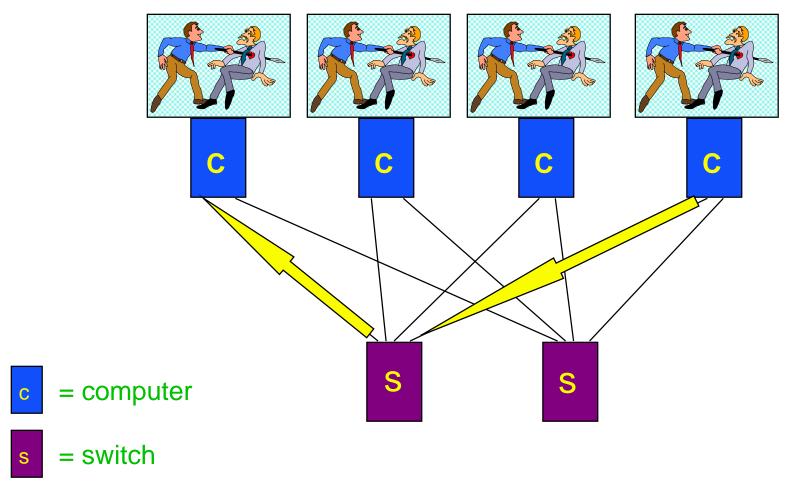
b+c



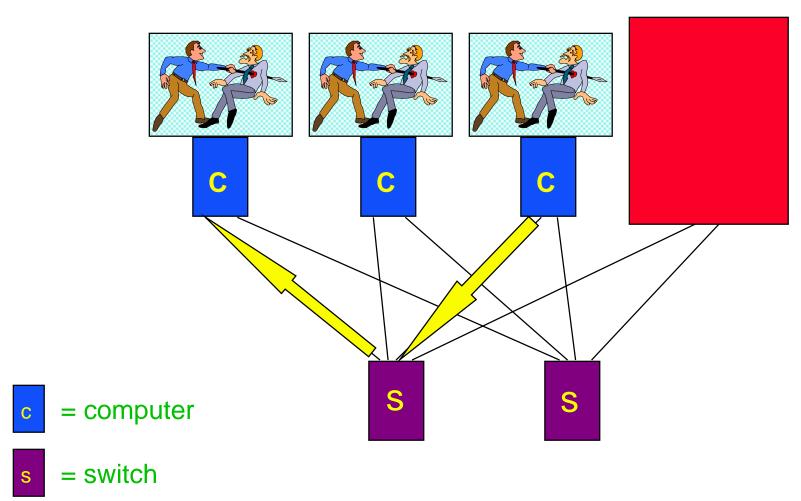
Reconstruction



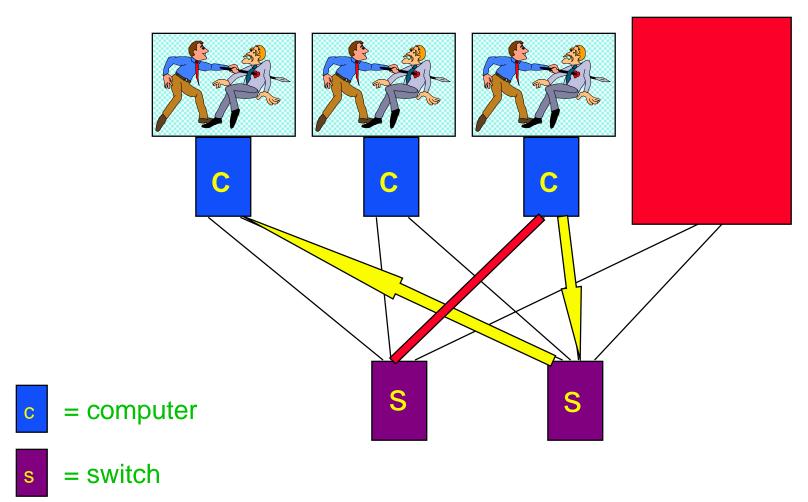
Finding a Mate



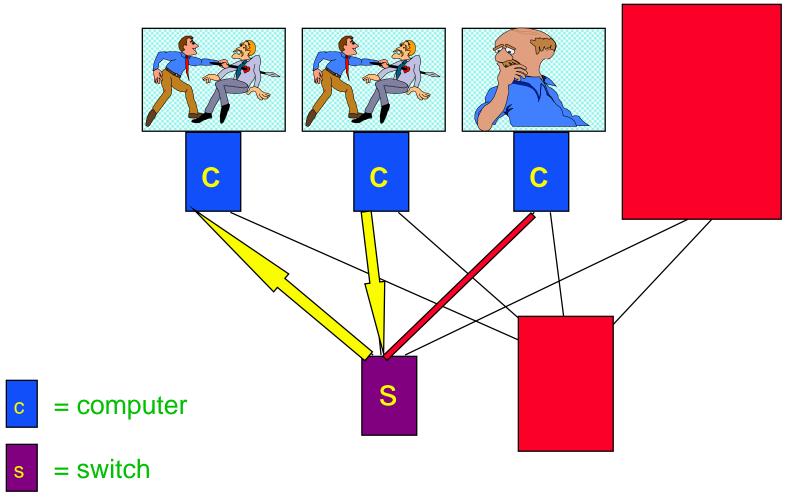
Computing Node Faults



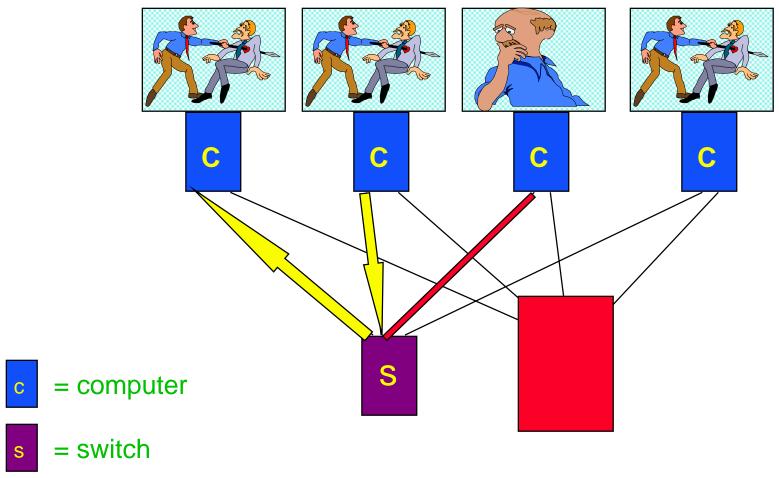
Link Faults



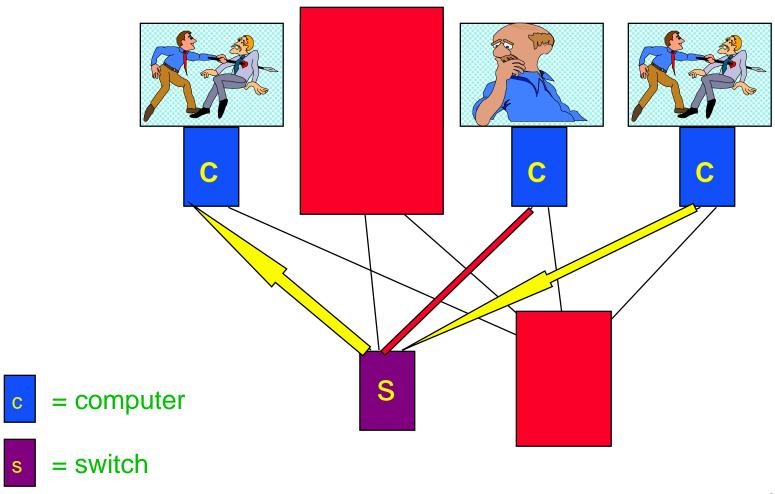
Switch Faults



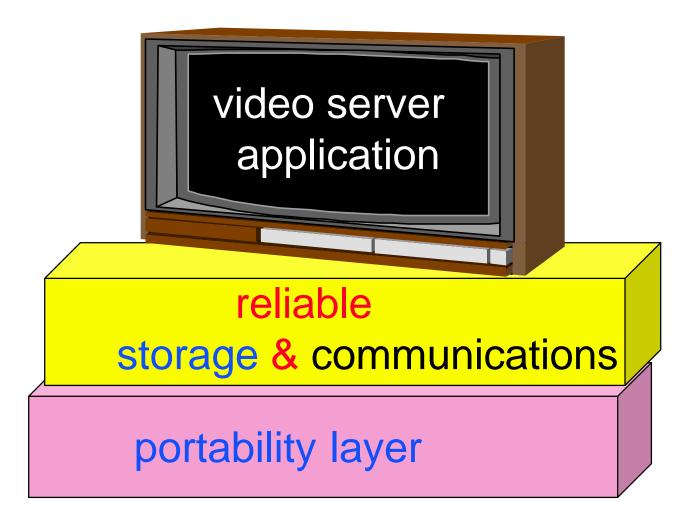
Getting Well



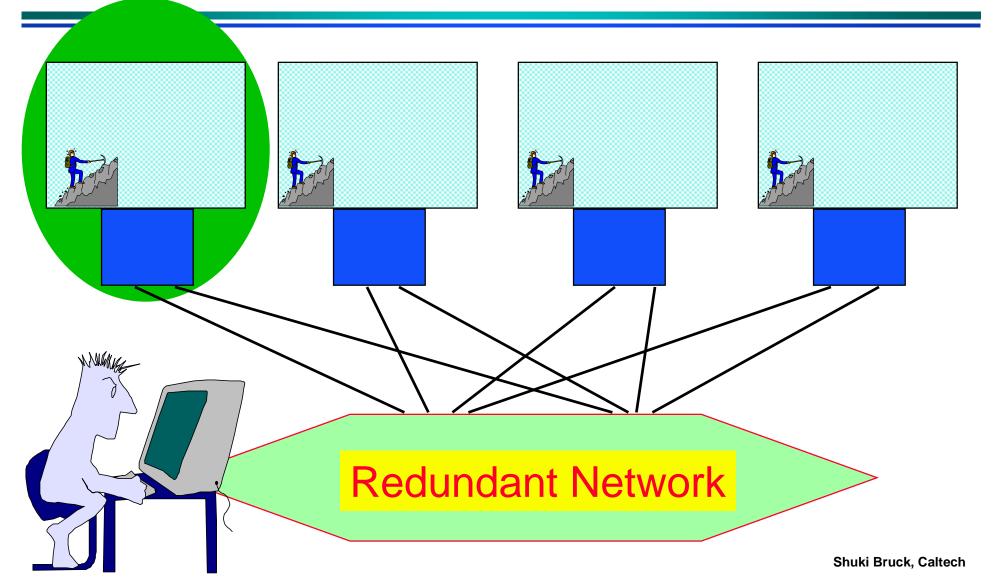
Continuous Reconfiguration



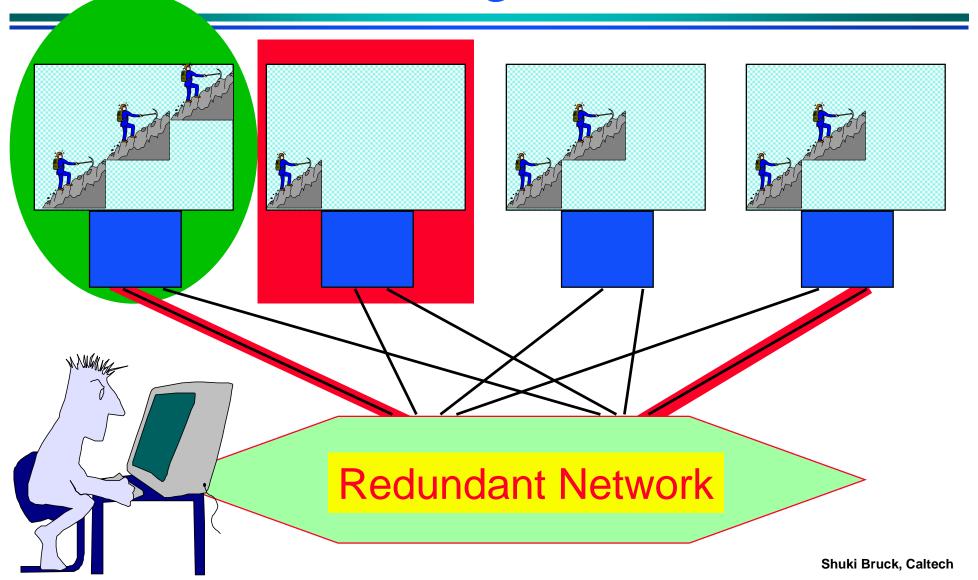
Building Blocks in RAIN 1.0



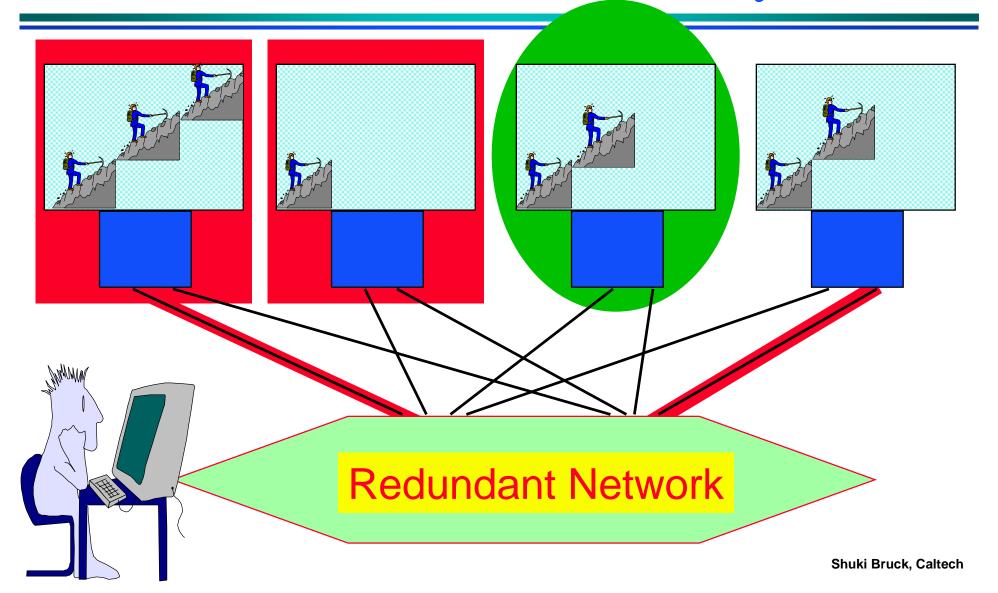
Distributed Checkpointing



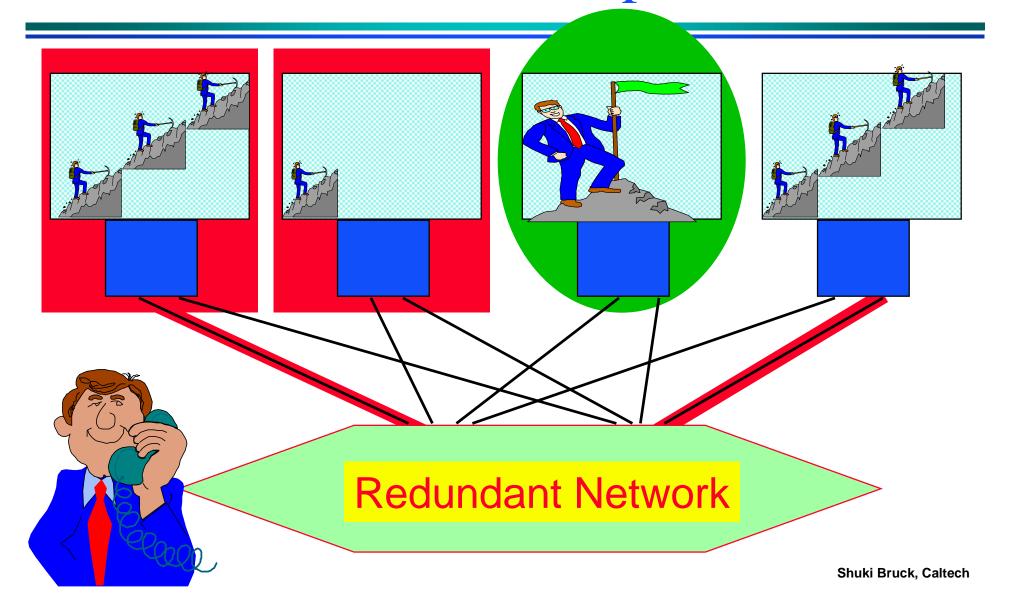
Masking Faults



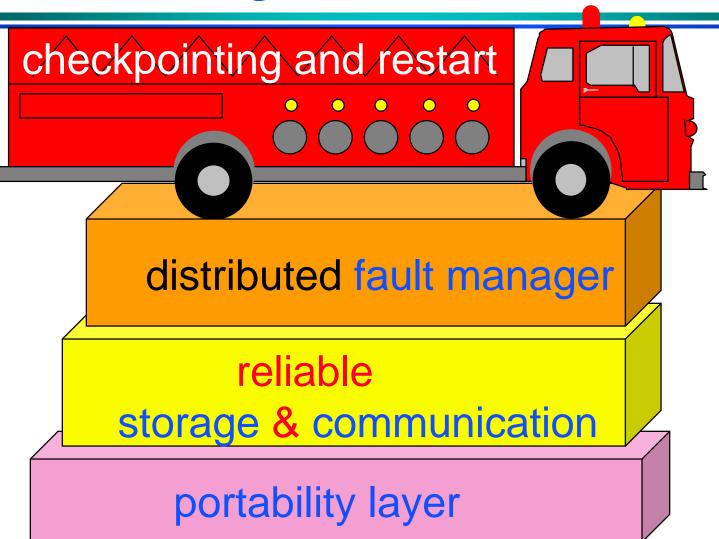
Fault Detection Rollback and Recovery



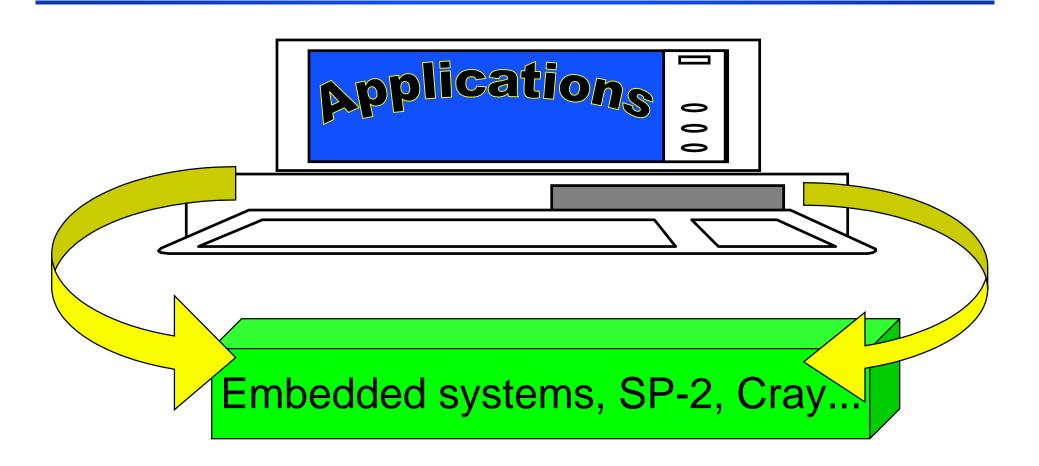
Successful Completion



Building Blocks in CPT 1.0



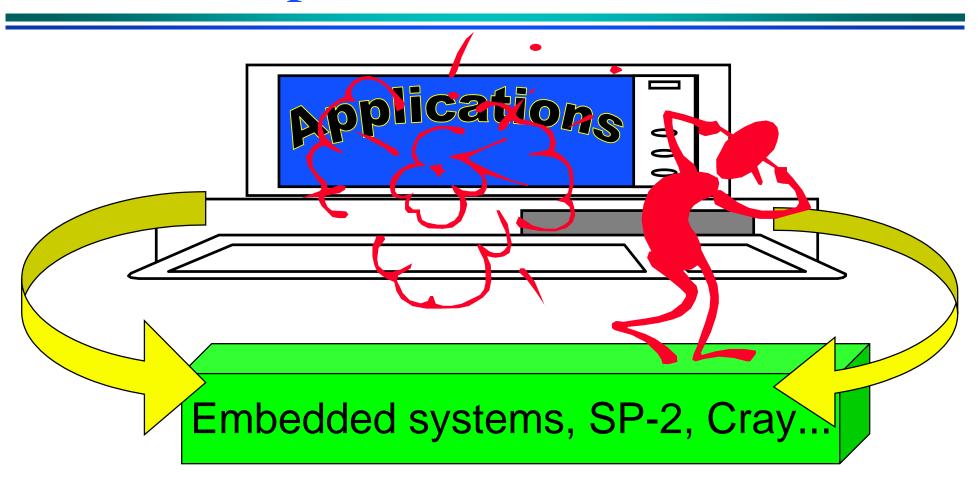
Standard API



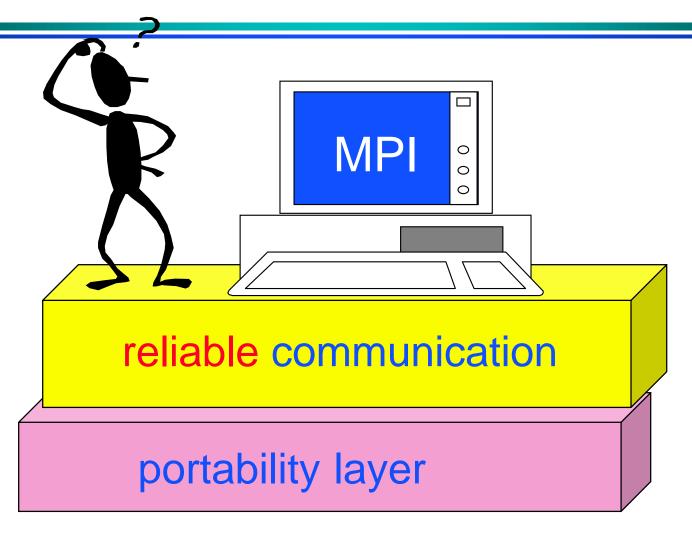
Parallel Programming API

Applications MPI (Message Passing Interface) portability layer Embedded systems, SP-2, Cray...

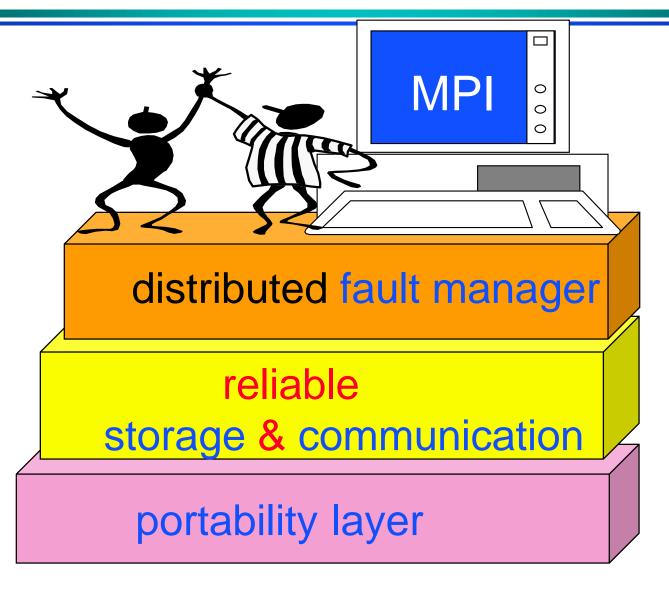
Standard API Transparent Fault Tolerance



Current Goal



Long Term Goal



Shuki Bruck, Caltech

Status and Current Activities

Systems

RAIN 1.0 at JPL

In development

RAIN 2.0+MPI

Distributed CPT 1.0

RAINWEB = SNOW

Theory

Networks

Protocols:

Communication Detection

Array codes

Algorithms: voting, checkptg load-bal, leader-elec

Shuki Bruck, Caltech